

15 years of APC implementation experience in the Petro-Chemical Industry

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Shell has developed a unique expertise while implementing Advanced Process Control (APC) in its own plants over the last 15 years. Three key messages have been learnt during that time:

- **APC can increase the plant margin by 10% to 20%.** Benefits come first from yield enhancement and plant feed maximisation.
- When APC is used at design stage it can allow **to avoid or to reduce significantly capital expenditure.** These benefits are less known but can be essential for the future of the plant.
- Critical factors for APC success are well known. **People** (experienced and well trained money-makers APC engineer), **Tools** (APC tools shall best use plant measurements to overcome the simplified models they use) and **Procedures** (to ensure successful APC project and to sustain APC benefits over the years).

This experience allows Shell Global Solutions to offer Shell expertise and Shell's APC tools to widely increase our third party customer's profitability in the world.

Introduction

Shell kicked off its APC activities at the end of the seventies. At that time, Shell was one of the few companies to believe in APC. The first activity was to develop Multivariable Predictive Controller. Two APC development centre were set up, one in the USA where the famous DMC controller was developed and one in Europe that used the original SMOC control framework based upon state space representation.

Over the years, the two technologies were enhanced. DMC became QDMC. The move to Quadratic DMC was a necessity to go over some original drawback of the DMC type of controllers. In Europe, SMOC was enhanced to include the Intermediate Variable and Unmeasured Disturbance concepts. Finally in the mid-nineties, Shell in the USA decided to select SMOC instead of QDMC because of the intrinsic and recognised superiority of SMOC.

The latest technology development in the nineties was to develop the original "Robust Quality Estimation" (RQE). Measurement has always been central in the APC

development. Historically, it has always been a wish to be able to infer measurements rather than implementing the very expansive quality analysers.

Each year, Shell Global Solutions is spending 2.5million USD to maintain and develop its APC technology.

Shell APC implementation track record

Following initial successful test in the early eighties, Shell started to implement APC in the mid-eighties. Since that time more than 600 controllers have been implemented within Shell companies.

Shell Global Solutions is regularly monitoring APC performances at our customer plants. APC has already generated more than 300 million USD per annum at Shell locations. If all possible APC applications would be installed, this figure could go up 500million USD. But new possible applications are now identified (e.g. liquefaction of natural gas), and this figure will be easily met.

Our survey allows to identify two key information:

- First, APC can yield 10% to 20% margin increase.
- Second the benefits are coming from Yield improvement (52%), Capacity increase (39%) and only 9% from Energy savings.

Other benefits have been identified but are not quantified:

- APC allows to increase the plant reliability. The Solomon study for Ethylene plant has identified a correlation between APC penetration index and production losses.
- APC first task is to stabilise operation. Increased plant stability requires less operator attention. Hence the operator can monitor more control loops.

APC and Process Design.

Very large benefits are also obtained when APC is used for process unit design. In a nutshell, APC can justify the following decisions.

- Avoid new unit construction or
- Allow unit capacity reduction.
- Optimise the quality measurement requirements and reduce the number of on-line analysers.

The savings in this case can be very large.

The green gasoil is the most recent example. In 2005, the European Automotive Gas Oil shall have a sulphur content below 50ppm. Following this first step, the sulphur content shall drop to 10ppm by 2008. This environmentally friendly decision is becoming a world standard. To face this challenge, the refining industry shall invest in new units that have a risky profitability because of the fluctuating refinery margin.

Shell Global Solutions has developed the “Green Gasoil” Customer Value Proposition to meet our customer wishes: “Meet the new legislation while minimising the capital requirements”.

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In this CVP, the key element is to consider the global pictures before deciding. There are 3 items to be considered at the same time.

- Invest in new units or change the catalyst. The first thought is to jump to these costly solutions that ensures to meet the requirements.
- Modify the crude oil diet, import/export components. These solutions can avoid capital expenditures but also deteriorates the plant operation margin. Thus it can end up to be less favourable than the above capital expenditure.
- Finally, Advanced Process Control can be considered to maximise the operation of existing or future equipments. Combined with other decisions, it can prevent to build new units (e.g. new catalyst plus APC) or minimise the necessary capital expenditure.

These APC benefits are not recorded in any benefits survey even if they can be much more important than the classical APC benefits.

Critical Factor for APC Success.

APC like any other tools require a sounded organisation to be successful. The classical triangle People, Tools and Procedures has also been identified to be critical for the success.

- ***People:*** APC engineers are moneymakers. They contribute directly to the profitability of the plant. They shall have an aggressive money making mindset. As such, any of their activities shall be justified on benefits. Initial and on-going APC training are necessary. It is also important that the APC engineer belongs to a network of APC engineers to develop his talents. Shell Global Solution's APC engineer network includes nearly 200 APC engineers working at our client's facilities.
- ***Tools:*** Leading APC technology is compulsory. APC is generally based upon linear models that are by essence rough approximation of the unit behaviour. The best APC tools are those who best use plant measurements to overcome this original approximation. Shell has developed SMOC and RQE having in mind this basic but fundamental concept.
- ***Procedures:*** Strong project methodology was developed over the last 15 years to ensure that any new project is successful. Best practices were also identified. First APC implementation shall be based upon benefits / costs study. This is essential to identify most profitable APC loops to be implement FIRST. The benefits of the first APC implementation generally yield the cash flow to finance the APC project thus avoiding unnecessary cash out. Second, a thorough process analysis is required at the detailed design stage to implement APC "right the first time". Finally, systematic APC performance monitoring shall be set up. The use of plant historian database and monitoring tools like Shell Global Solution's MD (Monitoring Diagnosis) is a must for any successful and sustainable APC benefits.